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Final Report
AFOSR – DURIP Grant F49620-96-1-0422
November 12, 1997

“Momentum Resolved ESDIAD – A New Way to Study Surface Dynamics Without a Laser”

John T. Yates, Jr.
University of Pittsburgh
Department of Chemistry
Surface Science Center
Pittsburgh, PA 15260

An existing older Varian UHV system has been modified so that the new momentum-selective ESDIAD system can be included. All necessary electronic parts and computers have been purchased and the majority of it has been tested and used in a preliminary version of the TOF-ESDIAD system. First results are already published (see references [1-3]).

- 1) The following extensive changes and necessary improvements of the UHV system have been made by installing and testing the following items (compare the attached equipment list): Custom built UHV chamber (item 14); New vacuum gauges, valves and other UHV hardware (items 15,...,18,22,24).
- 2) **Closed cycle Helium cryogenic system** (item 12): In order to perform dynamic measurements at the zero point energy level (compare attached publication [3]) a new design of the manipulator including the cooling and heating system was necessary. The constructions are completed and under test in the new chamber.
- 3) **Pulsed electron gun system** (items 13 and 8): The electron gun system has been built in the new chamber and aligned (using the Precision Off Axis Port Aligner, item 15). It has been tested using a self-made phosphor screen. By employing the Avtech pulse generator (item 8) electron pulses of widths down to 500 ps could be obtained. For the pulse widths measurements the multi-scaler system (item 2), the oscilloscope (item 3) and the computer (items 10 and 11) have been employed.

4) Specially designed detector system (item 9): A newly designed TDC (Time to Digital Converter) has been build and tested at the University's electronic shop. The ultra fast position detector system including the multi-parameter system (item 9) is under testing at the company Quantar Technology. The delivery of the system has been delayed due to problems with the Resistive Anode. The delivery is expected at the end of November.

5) Electronic equipment, pulsing and timing (items 1, 2, 3, 8, 10, 19, 20, 21, 23, 25): The full capability of the new system allowing the highly time and angle resolved TOF-measurements will be possible only after including the new detector in the system. Nevertheless preliminary TOF ESDIAD measurements have been successfully performed by applying the new electronic equipment for pulsing and timing to a modified older detector system (see references [1-3]).

References:

1. J. T. Yates, Jr., J. Ahner and D. Mocuta, "Tracking the Motion of Chemisorbed Molecules on Their Adsorption Sites," submitted to Proceedings of National Academy of Sciences.
2. J. Braun, J. Weckesser, J. Ahner, D. Mocuta, J. T. Yates, Jr. and Ch. Wöll, "The Frustrated Translational Mode of CO on Cu(110): Azimuthal Anisotropy Studies by Helium Atom Scattering- A Comparison with Time of Flight ESDIAD* Measurements," submitted to J. Chem. Phys.
3. J. Ahner, D. Mocuta, R. D. Ramsier and J. T. Yates, Jr., "Measurement of Anisotropy in the Lateral Momentum of a Vibrating Adsorbed Molecule – CO/Cu(110)," Phys. Rev. Lett. 79, 1889 (1997).

Item#	Manufacturer	Catalog#	Name	Acquisition Price	Comments	Changes to the equipment list
1	Stanford Research Systems 1290 D Reamwood Ave. Sunnyvale, CA 94089	DG535 -104C -105	Digital Delay/ Pulse Generator + -Option 4C Bias Tee -Option 5 Dual Rack Mount	\$3,750	Catalog Price: \$4,600	
2	EG&G Instruments, Inc., EG&G Ortec Division 100 Midland Road, Oak Ridge, TN, 37830	Model 9306 Model 9307 Model 9308 Model PCBCBC1 Model 566 4001A/4002D	1 Ghz Preamplifier Pico-Timing Discriminator Picosecond Time Analyzer Computer Interface with Cable Time to Amplitude Converter NIM bin & 160 W power supply	\$541 \$1,473 \$8,620 \$265 \$1,100 \$1,999	Catalog Price: \$605 \$1650 Discount Discount Catalog Price: \$1,650	Not Included Not Included Not Included
3	Tektronix, Inc. 700 Professional Drive, Gaithersburg, MD 20819	TDS744A	Digital Oscilloscope, 500 Mhz with Cart	\$12,200	Test Instrument	Upgrade from TDS540A in the equipment list
8	Avtech Electrosystems Ltd., P.O. Box 265, Ogdensburg, NY 13669- 265	9-AVR-E2-P5 AVX-1	Pulse Generator + EA, EW, OS Options and Inverting Transformer	\$4,227	Discount	Replaces HP Programmable Pulse Generator 8114A; \$9,450
9	Quantar Technology, Inc, 3004 Mission Street, Santa Cruz, CA	3392A	MCP/ RAE Sensor, 75 mm Diam. Active Area, 2MCP's, 1/100 Spatial Resolution	\$14,950	Not Received	

3392/001	Option 001/SE: Add Electrically Isolated Front Ring to Std. 3392A	\$350	
3392/SH	Option SH, Install 10K RAE Compatible w/Model 2502 in place of std	\$400	
3392/SM	Option SM, Install Hot Type MCP's instead of std	\$1600	
2502A	Model 2502A position Analyzer, High Speed	\$14,750	
2502/X98	Add option X98 Spec Modif. To 2502 for TDC Input to FIFO	\$600	
SPECMISC	Special Item: Modify 2502 data cables	\$450	
MPABBS	MPA Base System w/ Small Busbox w/3 ADC Interfaces, MPA-PC 1 MB board, factory config.	\$5,400	
MPA/2MB	Increase MPA board Memory to 2 MB	\$1,990	
MPAWIN	MPA Windows Based Software	\$5,650	

	MPA/REPLAY	Replay/Parser Software Option for MPAWIN	\$950	
	7070	Fast 100 MHz ADC, 8192 Channel, Nim Module	\$1,675	
	FRT	Freight Charge	\$177	
10	NSA Hitachi, 100 Lowder Brook Drive, Westwood, MA 01879	CM611U Hitachi/NSA Superscan Elite 611 Color Monitor/17"	\$700 Catalog Price: \$799	Changed Company
11	Gateway2000, 610 Gateway Drive, P.O. Box 2000, North Sioux City, South Dakota 57049-2000	Gateway G6-200 Computer	\$4,521	Changed Company
12	Advanced Research Systems, 1942 Riverbend Rd., Allentown, PA 18103	Closed Cycle Displex System + Programmable Temperature Controller + Model MB2002 Precision XYZ Manipulator + Model DPRF600 Differentially Pumped Rotary Platform	\$30,080 Discount	Included in Budget A
13	Kimball Physics Inc., 311 Kimball Hill Road, Wilton, NH 03086-9742	ELG-21EGPS-2 Low Energy Electron Gun System	\$15,440 Catalog Price: \$16,120	

14	Kurt Lesker Company, 1515 Worthington Ave. Clairton, PA, 15025	UHV Hardware	\$6,416.10	10% discount	Changed Manufacturer
15	MDC Vacuum Products Corp., 23842 Cabot Blvd., Hayward, CA 94545	Custom Built UHV Chamber	\$8,500		Changed Manufacturer
16	Pittsburgh Valve and Fitting Company, 49 Meade Ave., P.O. Box 4155, Bellevue, Pittsburgh, PA 15202	PAT-10 Precision Off Axis Port Aligner	\$650		
17	VAT, 500 West Cummings Park, Woburn, MA 01801	Precision Off Axis Port Aligner	\$750		
18	Varian Vacuum Products, 121 Hartwell Ave., Lexington MA 02173	Various Pre-vacuum Hardware	\$4598	University Discount	
19	National Instruments, 6504 Bridge Point Parkway, Austin, TX 78730-5039	Multi Gauge Controller, Various Transducers + PC Controller Boards and Cables	\$4,428.50	Discount	Included in Budget A
		PCI-GPIB and NI- 488 2M for Windows 95	\$495		Included in Budget A
		Type X2 double Shielded GPIB Cable, 2m, 2pc.	\$170		

		763061-04	Type X2 double Shielded GPIB Cable, 8m	\$105		
20	Hewlett Packard Co. (2609), 111 Zeta Drive, Pittsburgh, PA, 15238	HP6644A Opt 908	Single-output system and power supply: 200W Rack-mount Kit	\$1,912 \$29.60	Discount Not Included	Replaces Tectronix Power Supply
21	Dell Computer Corporation, One Dell Way, Round Rock, Texas 78682		Computer + Monitor	\$2,501		Not Included
22	Granville Phillips Company, 5675 Arapahoe Avenue, Boulder, Colorado, 80303-1398	203036-04	Variable Leak Valve / Cajon Connections/ Style 04	\$1,150		Replaces Balzers/ Pfeiffer Dosing valve in Budget A
23	Wavetek Corp., 9045 Balboa Ave., San Diego, CA 92123-1509	Model 81	50 Mhz Pulse / Function generator	\$4,080	Discount	Not Included
24	Matheson Gas Products, 166 Keystone Drive Montgomeryville PA 18936	2101182-0 3813-580	Argon, Research purity, 7A cyl. Regulator, dual stage high purity stainless steel	\$228 \$729		
25	D&K Electronics, 1224 East Carson Street, Pittsburgh, PA 15203	8x36 70ns	16 MB SIMM Memory Module, 2pc.	\$338		Not Included